SYSTEMS, DEVICES AND METHODS DELIVERING ENERGY USING AN UNCREWED AUTONOMOUS VEHICLE

BACKGROUND

Various devices consume energy during operation. Energy may be stored and distributed in various forms, such as mechanical, chemical, electrical, and so forth. For example, a vehicle may operate by drawing energy from spinning flywheels, combusting hydrocarbons, drawing electric current from capacitors, and so forth. Depletion of onboard energy may render the device inoperable. Continuing the example, the vehicle may have insufficient energy onboard to reach a recharging station thus stranding the vehicle. Depletion may result in an adverse user experience.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is an illustrative system for providing energy to a vehicle using an uncrewed autonomous vehicle ("UAV").

FIG. **2** is a schematic diagram of the vehicle configured to request and receive energy.

FIG. **3** is a schematic diagram of the server configured to provide instructions to a particular UAV to transfer energy to a device.

FIG. **4** is a schematic diagram of a UAV configured to travel to a vehicle and transfer energy to the vehicle.

FIG. **5** illustrates examples of the vehicle authentication data, the server authentication data, and the UAV authentication data.

FIG. **6** illustrates examples of a UAV's docking connector and a vehicle's docking mechanism, which when coupled may provide electrical contacts, fuel transfer connectors, and so forth.

FIG. **7** illustrates detailed views of the coupling between the UAV docking connector and the vehicle docking mechanism.

FIG. **8** is a flow diagram illustrating a process of charging a rechargeable battery of the vehicle using a vehicle, a server, and a UAV.

FIG. **9** is a flow diagram illustrating a process of a UAV traveling to a rendezvous location, docking, and transferring energy to a vehicle.

FIG. **10** is a flow diagram illustrating a process of providing an energy request to a server and receiving energy from a UAV.

Certain implementations and embodiments will now be described more fully below with reference to the accompanying figures, in which various aspects are shown. However, various aspects may be implemented in many different forms and should not be construed as limited to the implementations set forth herein. Like numbers refer to like elements throughout.

DETAILED DESCRIPTION

This disclosure relates to systems, devices and methods for delivering energy using an uncrewed autonomous vehicle ("UAV"). The UAV may comprise a mobile machine configured to operate in one or more autonomous or semi-autonomous modes. In a fully autonomous mode, the UAV may be configured to manage route selection, route navigation, route piloting, and so forth, without human intervention. In a semi-autonomous mode some human intervention may be utilized. For example, in a semi-autonomous mode a human operator may designate or approve a particular navigational route. The UAV may include an uncrewed ground vehicle, an uncrewed aerial vehicle, a drone, a remotely piloted aircraft, and so forth.

The UAV may transfer energy to a device. The devices which utilize energy for operation may include, without limitation, a vehicle, surveillance equipment, communications equipment, utility control equipment, and so forth. The vehicle may comprise a mobile machine that uses energy to move from one location to another. The vehicle may include a car, a truck, a bicycle, a bus, a motorcycle, a scooter, a train, a boat, a personal watercraft, an aircraft, another UAV, and so forth.

The vehicle may include an energy source that provides energy to perform processes for the vehicle. The energy source may use one or more of electric, chemical, or mechanical devices to store energy for operation of the vehicle. In one example, the energy source includes one or more batteries that supply electric energy to the vehicle. The batteries may be single use or rechargeable. During use of the vehicle, energy is drawn from the batteries. In other examples, the energy source includes fuel cells, internal combustion engines, external combustion engines, or other devices to produce energy. The devices may consume or otherwise use a reactant. The reactants may include, but are not limited to sugar, starch, alcohol, carbon monoxide, hydrogen, hydrocarbons (including gasoline, kerosene, propane, natural gas), and so forth.

The vehicle may include systems to manage the energy source of the vehicle. In some implementations, the vehicle monitors the amount of energy available from the energy source. For example, a fuel gauge may indicate a quantity of reactants remaining. The vehicle may determine whether there is a need for the vehicle to receive energy. For example, the vehicle may determine that the onboard fuel tank or battery has stored therein insufficient energy to reach a recharging station or other destination, and thus should acquire more energy. In some implementations, the vehicle generates energy request data representative of a request for energy. The vehicle may provide the energy request data to the UAV using one or more the networks discussed herein.

In some implementations, the vehicle provides the energy request to a server using one or more of the networks discussed herein. The server may be configured to select a particular UAV from a plurality of different UAVs. The server may be configured to select the particular UAV based on one or more factors. For example, the selection of the UAV may be determined based on distances between the UAVs and the vehicle, speeds of UAVs, costs associated with using the UAVs, amounts of energy available from the UAVs, docking speeds supported by the UAVs, and so forth.

Once the UAV receives instructions to transfer energy to the vehicle, the UAV may travel to a rendezvous location at which the transfer of energy may occur. The rendezvous location may include a particular location, or may include a range or area of different individual locations. In some implementations, for the UAV to meet with the vehicle, the vehicle may provide information about the location or motion of the vehicle. For example, the vehicle may provide motion information indicative of the speed of the vehicle, the direction of the vehicle, an anticipated action of the vehicle, an anticipated destination location, and so forth. The UAV may use the motion information to adjust the route to the rendezvous location.

The UAV may be configured to dock with the vehicle while the vehicle is or is not moving. For example, the rendezvous location for docking while in motion may comprise a particular length of highway which is free from